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Rotational Shiftwork:

A Summary of the Adverse Effects and Improvement Strategies

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Introduction

Shiftwork, in one form or another, is a fact of life for about 25% of the North American working population[1]. Alternating day, night and afternoon shifts are no longer something that only industrial workers, miners, hospital and railway personnel have to accept. Shiftwork has become common in the food, health, safety and transportation services. It is also common in certain industries where the technical processes cannot be interrupted without affecting the product and/or where expensive equipment is used more profitably when in constant operation.

Interest in shiftwork is skyrocketing as many experts are blaming rotating shifts for the 'human error' involved in nuclear power plant incidents, air crashes, and other catastrophic accidents. Many newspaper, magazine and television specials describe rotating shifts as a serious problem.

Many workers find that shiftwork disrupts their family and personal life and leads to health problems ranging from chronic fatigue to digestive upset. Humans seem to thrive on regularity, while any irregularity appears to create psychological and physical problems. These, in turn, affect the occupational health and safety of the worker. On the other hand, some workers prefer shiftwork. It seems more relaxed, weekends seem longer, there are opportunities to take courses and there are more daytime hours for personal activities.

The term 'rotational shiftwork' covers a wide variety of work schedules. These shifts can be either continuous, running 24 hours per day, 7 days per week, or semi-continuous, running 2 or 3 shifts per day with or without weekends. Rotational shiftwork implies that shifts rotate or change according to a set schedule. Workers take turns working on all shifts that are part of a particular system.

Fixed shifts such as straight nights or straight afternoons or straight days are not included in our definition of rotational shiftwork and therefore are not the focus of this paper. However, it should be remembered that workers on fixed night shifts and rotational shiftworkers have much in common due to the constantly changing schedules, nightwork and disruption to family and social lives.

Also, the length of a shift can vary between 8 and 12 hours. Special concern about the extended workday (10-12 hour shifts) is the subject of another CCOHS publication [13].

Adverse health and safety effects

The shiftworker, particularly one who works night shifts, must function on an abnormal schedule. The night shiftworker sleeps when most people are awake, and works when friends and family do not. The typical North American pattern of a five-day work week followed by two days of rest is replaced with constant changes

Adverse health and safety effects
continued

in schedules from one day or week to the next. Changing schedules like this can cause problems. Scientific studies throughout the world have demonstrated that shiftwork, by its very nature, is a major factor in the health and safety of workers.

Circadian rhythms

What has brought many of the problems of shiftworkers to new light is the increased knowledge of biological cycles in the body. Many human physical functions follow 24 hour cycles. These cycles are called circadian rhythms. The word circadian comes from the Latin 'circa dies' and means 'about a day'. Many different bodily processes follow a daily rhythm. For example, they regulate sleeping, waking, digestion, secretion of adrenalin, body temperature, blood pressure, pulse and many other important aspects of body functions and human behaviour. These rhythmical processes are coordinated with each other and with the day-night cycle to allow for high activity during the day and low activity at night.

Normally, the body uses cues from other body processes and from the environment such as clock time, social activities, the light/dark cycle and meal times to keep the various rhythms on track. The health problems from rotational shiftwork arise partly because the body rhythms are disrupted by changing eating, sleeping, and working schedules. The rhythms most affected by shiftwork are those that follow the pattern of activity during the day and rest during the night.

The body temperature is a good example of a typical body rhythm. The body temperature is highest during the afternoon and early evening (6 p.m.) and lowest in the early morning (4 a.m.), the typical times of activity and rest (see Figure 1). However, if the activity pattern is changed, for example, if the person is working at night, the body temperature does not vary over 24 hours as much as normal and it also does not totally adjust to the new schedule. The temperature rhythm as well as other body rhythms are out of phase both with each other and with the person's activity pattern. This can lead to feelings of fatigue and disorientation. 'Jet lag' is a term often used to describe these feelings.

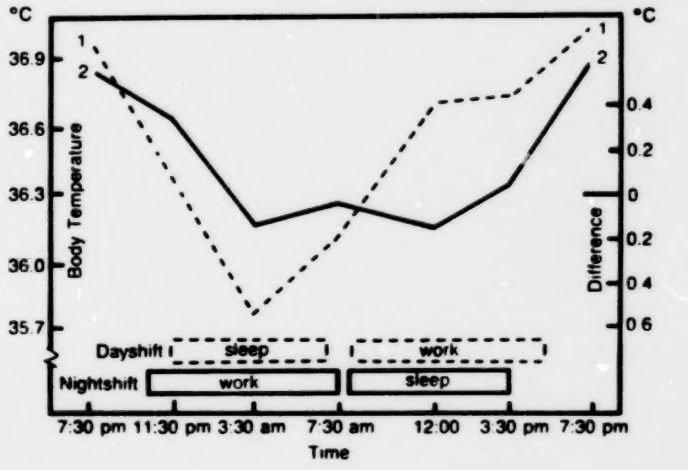
Some rhythms adapt in two to three days. Others change only after longer periods. People adapt to new schedules at different rates, as do the different rhythms. Total reversal of circadian rhythms may never occur because, on days off, most people go back to a normal day schedule. Frequent changes in schedule and disruption to circadian rhythms can lead to chronic fatigue and other health problems.

Sleep patterns

Being tired is one of the most common problems of the shiftworker. Disruption of the normal sleep pattern is inevitable in shiftwork, particularly where nightwork is involved. Both the quality and quantity of sleep are affected. The daytime sleep of the nightworker is seldom as deep or as refreshing as sleep at night. The problem is greater if the shiftworker does not have a quiet, comfortable place to sleep. Even when disturbances are removed, a worker who returns home in the morning may still find sleep impossible or less refreshing. This is because the circadian rhythms are no longer synchronized. The body is trying to gear up for activity when, according to the work schedule, the person should be sleeping. Persistent feelings of fatigue are common for the rotational shiftworker.

Figure 1[2]

Average body temperature curves of subjects on the dayshift (1) and on the nightshift (2)



Gastro-intestinal disorders

Gastro-intestinal and digestive problems are more common among shiftworkers than dayworkers[3,4]. This is not surprising, given the irregularity of the type and timing of meals. The shiftworker is more likely to have a poorer diet than the person who works straight day or afternoon shifts. He or she often has less access to wholesome food, particularly during the night shift. At night decreased appetite leads to increased snacking on 'junk' food rather than eating a full, well-balanced meal. Feelings of fatigue, especially during night shifts, may encourage the consumption of beverages with caffeine (coffee, cola) to help the worker stay awake. Also, the social conditions for eating while on shiftwork are often poor. The shiftworker no longer has meals with the family (or with anyone else).

Indigestion, heartburn, stomachache and loss of appetite are more common among rotating shiftworkers and nightworkers than among dayworkers. It is less clear if more serious conditions such as ulcers are more common in shiftworkers. Certainly the irregular

Gastro-intestinal disorders *continued*

work, sleep and eating schedules that go with rotational shiftwork are not helpful for the proper care of ulcers.

Heart attacks

Higher rates of risk factors for cardiovascular disease have been associated with shiftwork. A study of Swedish men with a history of heart attack showed they were significantly more likely to have been shiftworkers than those men without a history of heart attack[5]. On the average, shiftworkers have lifestyles which are associated with poor health and heart disease. In general, they smoke more heavily, are more obese, have poorer dietary habits, and participate in fewer leisure activities. It is more difficult for them to have a regular exercise program and this may contribute to a decreased level of fitness, an increased level of heart attack, an increased weight gain, and a decreased ability to cope with stress.

One study showed that the modification of shift rotation schedules by changing the direction of rotation of shifts to a forward direction (for example, days, afternoons, nights) can significantly decrease the levels of several coronary risk factors (triglycerides, glucose, and urinary excretion of catecholamines)[6].

Medication

Workers on night shifts who must take medication should be aware that it may not have the same effect on the body as during normal day schedules. Medication can have different effects depending on when it is taken. This can lead to safety problems because workers whose medications are not helping them may not be as alert or may have less physical ability to perform their work properly. They may be more susceptible to drowsiness when taking medication that can have this side effect.

Family and social life

Shiftwork can affect the individual and his or her family's participation in a whole web of family and social activities. Shiftworkers report more interference to their family lives, especially the time available to spend with spouses and children. This is a very important factor, since the amount and quality of social interaction is related to physical and mental health.

Individuals whose work hours do not allow them to form routines in their daily activities cannot plan for family responsibilities, take part in regularly scheduled off-job activities and cope with physical and mental fatigue as effectively as individuals who work on straight days. Rotational shiftwork forces individuals to move from one schedule to another at fixed intervals. By the time they have

Family and social life *continued*

adapted to one work schedule they are expected to move to the next one. Daily routines are therefore never formed.

Shiftwork does not allow for time off at 'normal' times and other time off does not carry the same social value. Participation in clubs, sports and other organized activities is very difficult since these activities are usually geared to the normal day schedule. Quality daycare to meet the needs of shiftworkers is almost nonexistent. Workers on fixed shifts spend more leisure time with their families and friends and less time alone than workers on rotating shifts[7].

The shiftworker's lack of regular social contact can lead to feelings of loneliness and isolation. Social researchers have concluded that an acceptable schedule of activities is necessary for satisfactory performance of social roles[8].

Safety

The causes of accidents are very complicated. Usually, no single factor can be identified as having 'caused' an accident. For shiftworkers, the disturbance of circadian rhythms can affect concentration and motivation, and slow reaction time, particularly at night. This can result in an increased risk of accident and injury.

However, there is disagreement about whether shiftworkers have a greater risk of injury. Studies can be found to show that shiftworkers' accident rates are less, the same or more than dayworkers. Part of the difficulty with the research is that conditions are not the same on different shifts[9]. For example, during night shifts the amount of supervision varies, the amount and sometimes the nature of the workload varies, the backup systems vary, and so on.

Nonetheless, lack of sleep aggravates the decline in performance normally experienced at certain times of the day. When deprived of sleep, a worker is less aware of the ways and extent that performance has deteriorated. Research has shown that the optimum mental performance level for workers occurs between 2 and 4 p.m. and maximum general awareness is between 1 and 7 p.m. Performance levels are lowest between 3:30 and 5:30 a.m.

Work conditions

In many cases workplaces and work are very different during the day from at night. The workplace varies particularly when lighting is altered (even in non-work areas like hallways) and ventilation is turned down or even off to conserve energy. Cafeteria services are generally unavailable at night. These types of changes increase the isolation of the shiftworker and make nightwork more stressful.

Work conditions *continued*

There are many aspects of work (for example, job design, environmental factors, communication) that influence health. These might increase or decrease the potentially negative effects of rotational shiftwork. Usually, night shifts are not as tightly supervised, workers are better able to help each other at night, and the more strenuous tasks are done in the daytime. However, depending upon the specific job and the organization, the opposite might also be true. Shiftworkers might have to endure harder working conditions, higher noise levels, higher speed requirements, more decision-making responsibility, or less support in terms of information resources or support services on certain shifts. Differences among shifts, then, involve more than just the time of day and the personal characteristics of the people working them. The varying conditions make the study of the effects of rotational shiftwork more difficult. It is clear however, that shiftworkers can benefit from efforts to minimize the special stressors they encounter.

Summary

In summary, there is evidence to suggest that shiftwork, particularly the nightwork component, disrupts circadian rhythms, impairs normal sleep patterns and results in a higher incidence of digestive disorders and heart disease. Shiftwork can also influence the action of medication. Shiftwork may be a contributing factor to workplace accidents and injuries.

Improvement strategies

The best solution to the occupational health and safety problems of shiftwork would be to eliminate it, but, this is not often a practical possibility. Shiftwork is likely to continue to be a fact of life for a large percentage of Canadian workers.

There are two basic levels at which to attack the problems of shiftwork:

- The organizational level does so primarily through shift schedule design, education and better facilities.
- The individual level focuses on helping workers to get better sleep, a healthier diet, and the reduction of stress.

Organizational approaches

There are a number of approaches the organization can take to help minimize the potentially adverse effects of shiftwork. There are several important considerations for organizations.

Shift schedule design

Optimizing the design of the shift schedule is the most effective way of reducing the health and safety problems of shiftwork. This is the best way to get to the source of the problem. Satisfaction with a particular shift system is the result of a complicated balancing act in which personal, psychological, social and medical concerns dictate the best available compromise for each worker's present life situation.

1. Consider the length of the rotation period. This refers to the number of days on any one shift before a rotation to the next shift occurs. The optimum length of the rotation period has been disputed. The most common system has a rotation period of one week, with five to seven consecutive night shifts. Just as adjustment starts to occur, it is time to rotate to the next shift. As a result, the body is constantly trying to adjust.

   Some schedule designers feel that a longer shift rotation should be arranged so that the shiftworker spends from two weeks to one month on the same shift[10]. This supposedly allows adequate time for adjustment of the circadian rhythms, which generally takes at least seven days. The problem here is that the worker reverts to a normal day schedule on days off, cancelling any adjustment of circadian rhythms. Also, long periods of social isolation result when shifts interfere with activities with family and friends.

   Others[11] suggest a rapid rotating shift system where shift rotations occur every two to three days. This supposedly reduces disruption to body rhythms because with rapid change, only a few night shifts at a time are required and the readjustment of circadian rhythms does not occur. Also, it provides time for some social interaction each week. Presently, this system is not widely used in North America.

   Based on scientific information, there is no way to determine which is the best length of rotation period. It may be preferable to use shorter cycles rather than longer cycles, as the physical advantages of longer rotations may be overridden by the psychological and social disadvantages. Individual differences and preferences obviously play a role.

2. Consider the direction of rotation of shifts. Some people recommend that shifts rotate forward from day to afternoon to night because circadian rhythms adjust more easily to moving ahead than back[12]. The underlying rationale for this

Shift schedule design *continued*

is that the human circadian system advances in this direction. The order of rotation can also affect the amount of free time on days off. For example, the first day off after night shift is spent sleeping.

3. Consider the time at which a shift starts and finishes. These times can affect sleep duration. Early morning shifts are associated with shorter sleep and greater fatigue prior to work than are later starting day shifts. It seems advisable to avoid shift start times as early as 5 a.m., but there is no optimal shift start time. The social customs and desires of the specific workforce should be considered when determining shift start and finish times. Also, the availability of public transportation is important. The safety of the streets, in terms of crime and violence, is another consideration.

4. Provide a rest period of at least 24 hours after each set of night shifts. The more consecutive nights worked, the more rest time should be allowed before the next rotation occurs.

5. Consider alternative forms of organizing work schedules. For example, extended work days of ten or twelve hours have been used in an attempt to alleviate the adverse effects of rotational shiftwork. The extended work day system has the advantage of fewer consecutive night shifts and longer blocks of time off. However, the additional fatigue from long work hours may have adverse effects. The length of the shift should be dependent upon the physical and mental load of the task. Exposure to chemical or physical agents should also be considered when selecting a shift system. Another CCOHS document discusses the health and safety aspects of the extended work day[13].

6. Provide time off at socially advantageous times like weekends whenever possible.

7. Institute a special shift system if production demands result in extended periods of overtime work.

8. Inform shiftworkers of their work schedules well ahead of time so they and their families and friends can plan activities. Allow as much flexibility as possible for shift changes. Keep schedules as simple and predictable as possible.

Facilities

The provision of certain facilities can help the shiftworker cope.

1. Give attention to the work environment. For example, good lighting and ventilation are important on all shifts. In particular, attention should be paid to lighting the approaches to work places and the corridors between them. Good lighting can help 'lighten the mood' of nightworkers. Minimize social isolation by quieting noisy equipment that prevents speech. Remove visual barriers, and do not widely separate workstations. In some cases music can help combat excessive quiet.

2. Provide rest facilities where possible. Whenever the shiftworker must remain at work in order to attend a meeting or a training session, it is advisable to provide rest facilities. In occupations where a night shiftworker is 'on call' as back-up staff, it is advantageous for this person to be well rested rather than tired and bored.

3. Provide good cafeteria services so shiftworkers can maintain a balanced diet. The nutritional needs of the rotational shiftworker differ between day and non-day shifts because of circadian rhythms.

4. Consider offering facilities for social activities with the needs of the shiftworker in mind since recreational opportunities are often minimal for workers on non-day shifts.

5. Consider access to quality daycare for shiftworkers' children. This would alleviate some of the strain on all family members.

Education

1. Educate employees on the potential health and safety effects of rotational shiftwork and what can be done to alleviate these effects. In particular, education about stress recognition and reduction techniques is helpful.

Individual approaches

People who work shifts face many problems that the others do not recognize. The difficulties stem from changing eating, sleeping, and working patterns. Shiftworkers can follow some specific guidelines to help cope with rotational shiftwork.

Guidelines for diet and eating patterns

1. Maintain regular eating patterns as much as possible. Balanced, varied meals are very important. Keeping family meal times

Guidelines for diet and eating patterns *continued*

is important for stability when work routines constantly change. Family meals may need to be altered in content to suit the shiftworker.

2. Relax during meals, and allow time for digestion.

3. Time meals carefully. Afternoon workers should have the main meal in the middle of the day instead of the middle of the work shift. Night shiftworkers should eat lightly throughout the shift and have a moderate breakfast. In this way they should not get too hungry while sleeping during the day, and digestive discomfort should be minimal.

4. Pay careful attention to the type of food eaten. Drink lots of water and eat the usual balance of vegetables, fruit, lean meat, poultry, fish, dairy products, grains and bread. Eat crackers and fruit instead of pop and candy bars during work breaks. Minimize the intake of salt, caffeine, and alcohol. Avoid greasy foods, particularly at night.

5. Avoid excessive use of antacids, tranquilizers and sleeping pills. It is healthier to watch what you eat and when you eat and use relaxation techniques to aid sleep.

Sleep

1. Sleep on a set schedule to help establish a routine and to make sleep during the day easier.

2. Make sure that family and friends are aware of and considerate of the worker's sleep hours and needs. They should ensure that the shiftworker has a comfortable, quiet place to sleep during the day. Air conditioning, a telephone answering machine, and good blinds on windows are examples of devices that may improve the shiftworker's sleep.

3. Make time for quiet relaxation before bed to facilitate better sleep. Learn how to relax using muscle relaxation, breathing techniques and so on. Use mental imagery to block out unpleasant thoughts. If you still do not fall asleep after an hour, read a book or listen to quiet music on the radio for a while. If sleep still does not come, reschedule sleeping hours for later in the day. Limit commitments later in the day to allow for napping.

Other important considerations

1. Pay attention to general physical fitness and good health habits.
2. Find out about and understand the potential health and safety effects of shiftwork.
3. Learn how to recognize and reduce stress through physical fitness, relaxation techniques and so on.
4. Take leisure seriously.

Conclusion

The shiftworker is at risk for health problems because of irregular patterns of eating, working, socializing, and sleeping. The result can adversely affect physical and psychological health. Special care must be taken by both the shiftworker and the employer to prevent as many of the adverse effects as possible. Design of the shift schedule to make it compatible with the body's circadian rhythms is an extremely important factor. Cooperation of the employer, the shiftworker, and the family of the shiftworker is essential.

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